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December 1, 1988

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Ms. Donna R. Searcy
Mass Media Bureau
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

RE: Tentative Decision and Further Notice of Inquiry
Advanced Television Systems
MM Docket No. 87-268

Dear Ms. Searcy:

Transmitted herewith on behalf of Tele-Communications, Inc. ("TCI"), is an original and five (5) copies of the Engineering Report appearing as "Attachment 1" to TCI's Comments in the above-captioned matter, filed November 30, 1988, which contained a tele-facsimilie of the enclosed. Please note also, the following Erratum correcting footnote 6, page 4, of Attachment 1 to TCI's Comments as follows:

> [6]"Preliminary and Partial Study of the Use of the UHF Band to Accommodate Local High Definition Television," Appendix B, comments of Association of Maximum Service Telecasters, November 18, 1987.

Should you have any questions, please contact the undersigned.

Very truly yours,

James E. Meyers

James E. Meyers
Counsel for
TELE-COMMUNICATIONS, INC.

JEM:btc:TCI
Enclosures

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ENGINEERING STATEMENT

IN SUPPORT OF COMMENTS

BY

TELE-COMMUNICATIONS, INC.

IN THE MATTER OF

ADVANCED TELEVISION SYSTEMS

AND THEIR IMPACT ON THE EXISTING TELEVISION BROADCAST SERVICE

MM DOCKET 87-268.

November 30, 1988

MOFFET, LARSON & JOHNSON, INC.

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ENGINEERING REPORT ON BEHALF OF TELE-COMMUNICATIONS, INC.

I. INTRODUCTION

This Engineering Statement was prepared by Moffet, Larson & Johnson, Inc., consulting telecommunications engineers, in support of Comments by Tele-Communications, Inc. in the matter of Advanced Television Systems and Their Impact on the Existing Television Broadcast Service, MM Docket 87-268.

In less than two years, the present television standard, commonly known as NTSC[1], will be a half-century old. In 1941, the NTSC transmission standard established the basic parameters for broadcast television, including maximum resolution, aspect ratio, and frame rate. Working within that framework, numerous video services sprang forth to make television a major source of entertainment and information for the public. The demand for heightened realism in television pictures led to the development of color television and numerous improvements in the equipment used to televise, record, transmit and receive standard NTSC video.

Advances in technology by the 1970s led to the development by NHK (Japan Broadcasting Corporation) of a separate, new high-definition television (HDTV) system. This system is capable of displaying an image quality comparable to 35mm film, but it is not a transmission system due to its extreme bandwidth requirements. For example, NHK/HDTV in its raw form would require five contiguous NTSC channels or 30 megahertz to convey the picture.[2] The need for much more radio frequency spectrum, not to mention the incompatibility with present receivers and broadcast equipment, has delayed introduction of HDTV. Both Japan and the European community have developed spectrum-efficient HDTV systems intended for distribution by direct broadcast satellite. Neither group has yet established an HDTV system for terrestrial broadcast.

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1 The National Television System Committee (NTSC) was convened in 1940 to establish technical standards for a monochrome television broadcast system.

2 NHK has developed a bandwidth-compressed HDTV system, known as MUSE. This system is encodes the 1125-line/60-field format into a signal requiring 8.1 MHz, approximately one and one-third times the spectrum used by NTSC. Because the required bandwidth is not compatible with the U.S. broadcast TV allocation system, MUSE is considered of primary value in direct broadcast satellite service.

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There are a number of promising techniques under development to provide Advanced Television Service (ATV). For purposes of discussion in this report, the proponent systems are divided into two groups, those systems which comply with the present 6 MHz allocation structure, and those which require more than 6 MHz of spectrum. All use an analog transmission format.[3]

Within the 6 MHz bandwidth group are two subgroups, determined by NTSC receiver compatibility. Several of these systems are compatible with existing NTSC receivers, but provide some combination of reduced NTSC artifacts, wider aspect ratio, and increased resolution for specially-equipped receivers. These systems are defined herein as enhanced-definition television (EDTV). There are other proposals that are not compatible with NTSC which propose to occupy no more than 6 MHz; constrained only by 6 MHz bandwidth, optimum image processing and modulation schemes may be utilized.

A second major group provides higher resolution and/or improved freedom from artifacts, but requires more than 6 MHz spectrum. Again, these systems fall into two subgroups; those which add an augmentation channel (usually 3 MHz or 6 MHz wide) in addition to the NTSC bearer channel, and those like MUSE that require a contiguous block of spectrum larger than 6 MHz.

This report discusses technical and regulatory issues involving allocation-compatible and non-compatible approaches: those factors which affect the quality of present NTSC services, require additional spectrum allocations, complicate interchange between various television media, and affect advancement of future.

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3 The SCHDTV system proposed by Zenith Corp., Glenview, Illinois, is an analog/digital hybrid format.

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1) The impact of ATV systems requiring additional spectrum in the UHF-TV band must be critically assessed in terms of possible interference effects to existing UHF broadcast service.

The present broadcast transmission standard, NTSC, serves the public well and will not disappear for many years. However, relaxation of UHF-TV interference standards and allocation taboos to accommodate High Definition Television (HDTV) most certainly will degrade present television service. Without question, more detailed spectrum analysis is required before a system choice can be made.

In the interim, it is highly unlikely that a de facto HDTV standard will emerge, so long as the NTSC broadcast transmission standard is maintained by the FCC. The challenge to provide substantial improvements in video quality has prompted considerable research into methods to improve NTSC or provide apparent HDTV quality within a reduced bandwidth. Today there are a number of promising techniques for the improvement of United States broadcast video which may be divided into two primary groups: those operating within the present 6 MHz NTSC channel, and those operating with a separate augmentation channel of 3 MHz or 6 MHz width in addition to the present NTSC channel.[4]

On the basis of preliminary engineering studies, the FCC Advisory Committee[5] reported that "sufficient spectrum capacity in the current TV allocations might be available" to allow all existing full-service TV stations with an augmentation channel. However, this view makes several fundamental assumptions. First, it assumes that some present UHF channel separation requirements, often referred to as "taboos", may be eliminated. Second, it assumes that the cochannel and adjacent channel interference protection requirements may be "substantially" relaxed from what they are now. Third, augmentation channels may eliminate most, if not all of the Low Power Television (LPTV) and translator service carried on UHF-TV channels, as well as spectrum reserved by the Commission for

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[4] Some systems propose to wholly replace the NTSC signal with an improved, non-compatible 6 MHz signal channel. Since the signals are not receiver compatible, these proposals are unlikely to prevail in this proceeding and are not discussed herein.

[5] On November 17, 1987, the FCC established an Advisory Committee on Advanced Television Service to study technical and policy issues related to ATS.

the land mobile radio industry for future expansion.[6] Fourth, introduction of broadcast HDTV using separate augmentation channels requires spectrum not available to other television media, such as cable television, Instructional Television Fixed Service (ITFS) and Multipoint Distribution Systems (MDS).

The present television allocation standards provide for a variety of protective taboos involving the second, third, fourth, fifth, seventh, eighth, fourteenth and fifteenth adjacent channels of UHF-TV stations. Elimination of some UHF-TV allocation taboos may be possible if improvements in receiver performance are mandated. For example, local oscillator radiation in HDTV and new NTSC receivers may be reduced, thereby relieving interference from these receivers to HDTV and NTSC service. However, these improvements would not apply to the millions of older NTSC sets, possibly creating an undetermined amount of interference to HDTV and NTSC reception. Similarly, receiver intermodulation effects involving HDTV-HDTV and NTSC-HDTV signals depend on the specific characteristics of the HDTV signal. Until we know the modulation scheme, we cannot determine which taboos can be relaxed.

Prediction of UHF-TV cochannel and adjacent channel interference is similarly problematic. The spectral characteristics of 3 MHz and 6 MHz augmentation channels will be considerably different from other UHF NTSC signals, to be sure. Some characteristics proposed may reduce interference to cochannel and adjacent channel NTSC service, among these are pure single-sideband modulation and reduction or elimination of synchronizing pulses. However, differences in HDTV augmentation channel signals relative to NTSC signals may limit the effectiveness of frequency offset, a factor which has provided much closer spacing of currently allocated cochannel NTSC services. The estimation of cochannel and adjacent channel interference from HDTV augmentation signals cannot be known without psycophysical testing using actual prototype HDTV systems. Unfortunately, very few of the proposed systems are in operation, and many still require months or years to refine and build.

Development of HDTV for every full-service television station through the addition of separate augmentation channels must rely on availability of vast amounts of UHF-TV spectrum. Initial studies[7] suggest that not enough UHF broadcast spectrum may be available to

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6 [see engineering study contained in comments of Association of Maximum Service Telecasters - need cite]

7 Initial Comments of The Association of Maximum Service Telecasters in MM Docket 87-268, November 18, 1987.

provide 6 MHz augmentation channels, while 3 MHz augmentation channels may be in sufficient supply if LPTV and translator services are eliminated where necessary, along with UHF channels reserved for the land mobile industry.[8] Most severely impacted will be large markets, where most viewers reside.

An HDTV system employing a separate augmentation channel will require additional spectrum not necessarily available to all television media. Cable television service are likely to prefer a broadcast HDTV signal that can be frequency-translated directly into the cable system, in the manner that TV signals carrying NTSC Color and Multichannel Sound are carried now. If separate augmentation channels are required for HDTV, however, cable services would have to increase system bandwidth by 3 MHz or 6 MHz for each broadcast channel carried - a total possible increase of fifty percent or one-hundred percent, respectively, in system bandwidth.

Increasing system bandwidth is economically infeasible for many cable services since it may require new amplifiers, equalizers, tuner/decoders, and possibly even the cable itself. Cable Television Relay Service Stations (CARS), used by many cable systems for signal distribution, also have insufficient spectrum to support any HDTV approach that requires additional channel bandwidth. In an effort to conserve valuable spectrum, cable services would be forced to delete some television services to accommodate augmentation channels, develop a non-compatible (but spectrum efficient) HDTV system, or not carry HDTV at all.

Video services such as ITFS and MDS would have to find supplementary spectrum, presumably within their service, to carry HDTV augmentation channels. Even if spectrum were available, complicated frequency conversion or tuning arrangements would be required for cable and other non-broadcast television media if HDTV relies on separate augmentation channels.

Studio Transmitter Link (STL), Intercity Relay (ICR) and Electronic Newsgathering (ENG) systems are already in heavy demand with existing 6 MHz NTSC video/audio. These vital services would be severely impacted by ATV systems requiring additional spectrum for augmentation channels.

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[8] The FCC reallocated a number of UHF-TV channels to the land mobile service in General Docket No. 85-172.

Transmission costs are a factor yet to be explored by the FCC or its Advisory Committee. Construction of UHF augmentation channels involves staggering costs for additional transmitter(s), antenna, and transmission line or waveguide. Existing towers may not support the additional antenna systems. UHF transmitter power costs for an additional 3 mHz or 6 MHz channel may be prohibitive. Smaller market and some independent stations may lack the financial means to provide HDTV that relies on separate augmentation channels, thereby reducing programming opportunities for some television services.

2) Recent studies tend to indicate the penetration of HDTV in consumer homes will be slow. The current haste in selecting an HDTV standard presents the distinct possibility of establishing a less-than-optimal system, and may hinder future advancements in HDTV and in home video technology.

A study completed this year for the NTIA[9] suggests a gradual penetration for HDTV:

> "If the growth path of ATV receivers and VCRs traces the historical sales tracks of conventional color television receivers, videocassette recorders, home computers and television receive-only [satellite] antennas, the new products will achieve one percent household penetration about ten years from now...[and] may reach 25% in about fifteen years and in twenty years may exceed 70% household penetration."

The report discusses the uncertainties of growth predictions, suggesting an array of scenarios which may further inhibit ATV, such as continuing uncertainty about spectrum constraints and receiver standards, delay in research and development programs, high ATV product prices, poor economic conditions, etc.:

> "Should these illustrative conditions arise, wholly or in part, it is quite conceivable that the one percent threshold would not be realized until well after the year 2000, and that subsequent growth would also be dampened."

On the other hand, several steps may be taken that support more rapid diffusion of ATV products, including timely and decisive regulatory action respecting standards and spectrum, and rapid development of high-quality, moderately-priced consumer equipment and program sources.

The analysis prepared for NTIA supports the position that an HDTV system requiring less development time, minimal spectrum regulation issues, and moderate pricing would be most viable. The introduction of ATV receivers based on enhancements compatible with NTSC video and operating without supplementary augmentation channels meets these

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9 Economic Potential of Advanced Television Products, Report by Darby Associates for the National Telecommunications and Information Administration, April 7, 1988.

factors. ATV systems relying on NTSC plus augmentation channels, however, will require more development time, will have complicated allocation issues to resolve, and are highly likely to cost more than enhanced NTSC systems in both transmission and reception.[10] The augmentation channel approach will certainly deter further advancement of ATV systems, such as development of digital high-definition television (D-HDTV), perhaps killing it entirely.

The TV displays used by most viewers are CRTs (cathode ray tubes, better known as "picture tubes"). Realistically, the maximum size of these CRT displays are limited by the unit cost, cabinet size, and weight, to a diagonal dimension of about 30 inches. (CRTs up to 45 inches have been developed, but the cost, size, and weight of these units are prohibitive for most consumers.) A diagonal of 30 inches results in a picture height of about 18 inches (based on a 4:3 aspect ratio). It has been customary to evaluate NTSC at a viewing distance of three times the picture height and HDTV systems at four times the picture height,[11] which works out to a distance of 54 inches (4-1/2 feet) for NTSC and 72 inches (6 feet) for HDTV (assuming the same CRT picture height for both.

Most homes appear to have television viewing distances of nine to 12 feet, regardless of picture size. (This distance is probably due mostly to furniture arrangements and room size.) For the 30-inch screen example, these distances equal six to eight picture heights. Within this common range of distances, it is doubtful that a large percentage of the viewing public will be able to discern a difference between HDTV and NTSC, particularly if EDTV enhancements are applied to the NTSC picture.[12]

While prompt introduction of ATV technology is desirable, the push to develop a terrestrial HDTV system requiring a complicated augmentation channel approach that is possibly subject to interference and propagation limitations is not good engineering. As will be discussed later herein, other more suitable technologies are at hand to provide HDTV service for the future.

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10 The economic impact of complex ATV systems is discussed in the FCC's Tentative Decision and Further Notice of Inquiry in MM Docket 87-268, released 9/1/88, at 38-39.

11 A standard employed by the CCIR (International Radio Consultative Committee) and other broadcast authorities.

12 While projection systems provide very large picture sizes with the potential to reveal high picture quality, equipment cost and bulk is expected to keep sales low for a number of years. Projection systems also suffer from visual defects, such as washout from extraneous room light, off-axis brightness loss, and focus and registration problems which tend to limit picture quality.

3) The ultimate goal of consumer HDTV should be image quality and aspect ratio similar to 35mm film with several channels of Compact Disc-quality audio. However, the HDTV proponent systems which rely on separate augmentation channels may not be able to deliver this quality to most viewers due to the vagaries of UHF signal propagation. Digital transmission has been shown to be more resistant to interference than analog format transmission.

Reliance on augmentation channels for HDTV broadcasting presents a number of problems. Foremost is the difference in propagation between the NTSC baseband on one frequency and a related augmentation channel on another frequency. UHF signals, because of their shorter wavelength, are subject to more attenuation by terrain shadowing, man-made obstructions, and absorption through trees, buildings, etc. Even with identical transmit and receive sites, it is likely that some viewers will receive an acceptable picture on the VHF channel (channels 2-13) carrying the baseband NTSC signal, but will not receive a usable augmentation channel signal on the UHF channel. The reverse condition is also possible.

Increased terrain attenuation of UHF relative to VHF increases the number and size of "holes" in the coverage area, meaning that the service area of an augmented HDTV service will be smaller than the NTSC baseband signal (if the NTSC signal is carried on a full-power VHF station). A portion of the viewing public will be foreclosed from receiving these HDTV transmissions.

UHF reception is often inadequate on indoor "loop" antennas, due to absorption of the signal as it travels through walls of the building, and because these antennas have relatively low gain. An outdoor UHF receiving antenna may be required to provide a sufficiently noise-free, multipath-free signal. This may not be possible for viewers in communities with covenants against outdoor antennas of any kind.

Transmission of EDTV within the station's present channel (whether the channel is VHF or UHF) makes it likely that a given viewer with satisfactory reception has the proper conditions to also receive the picture enhancements. This is less likely for augmented HDTV service.

Present television transmission is an analog process; picture information is conveyed by a continuously-variable carrier which follows the brightness (luminance) of the picture. Any disturbance of the incoming signal, such as multipath-delayed signals (ghosting in both terrestrial broadcast and cable systems), noise, or interference are impressed on the picture information. Digital transmission, on the other hand, converts the information into a binary signal of "ones" and "zeroes".

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Moderate disturbances characteristically have a lesser effect on digital signals, since the disturbance must reverse the state of the ones and zeroes to interfere. Further, digital transmissions can employ "error correction" within the data stream, thus detecting and correcting for erroneous bits. This technology is commonplace in the computer industry.

As an ultimate approach to HDTV, digital transmission offers clear advantages over analog transmission, including consistent performance, greater resistance to interference, and easier adaptation to sophisticated signal processing for both transmission and reception.

Recognizing the advantage of digital transmission, NASA (the National Aeronautics and Space Administration) has announced its intention to design a digital high-definition television system.[13] NASA plans to develop a D-HDTV by 1996 as a "baseline for the video system" of its space program. NASA's development of D-HDTV suggests numerous applications to industry and the public in the years to follow.

Digital television, for all its advantages, appears to be an inevitable development. If support and effort is directed toward 6 MHz broadcast digital TV, it could become a reality within ten years, which is not a long period of time, in consideration of the predictions of gradual penetration of HDTV systems in the home (even if HDTV were immediately adopted).

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13 "NASA Intends to Develop HDTV System", Multichannel News, pg. 39, October 24, 1988.

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4) Development of recording techniques, control systems, image processing and displays, (some of the primary components of television) show a definite trend toward digital systems. The analog HDTV approaches being advanced today may be superseded by digital video technology in a relatively short period of time.

The recent history of electronic engineering indicates that in most applications, subsystems similar to the types used in television have transferred from analog designs to digital designs. The most recent example of a shift in a major consumer system is the transition from analog audio on long-playing record and tape to digital audio via Compact Disc (CD) and Digital Audio Tape (DAT). The Compact Disc medium illustrates the economies of large-scale integration of digital circuits used in the player, while providing consistently high quality audio via the digital medium.

Other systems in consumer equipment have experienced transition from analog to digital format, as well. The tuner in most high-performance television and radio receivers are now digitally-controlled employing frequency synthesizers and digital displays. So are timers, remote controls, color subcarrier detectors, luminance channel comb filters, and other devices. The distinction between digital and analog circuitry often becomes quite blurred at the level of integrated circuits or "chips" within television equipment, where many functions are carried out by hybrid devices which rely on the precision and reliability available from digital processes.

As flat-screen displays develop, it is likely that these devices will employ digital systems to process, store, and scan the electronic image. There is evidence to suggest that future television processes, including encoding and transmission, would be more precisely, consistently, and economically handled in the digital domain.

For example, digital VCRs are already in use by TV production centers, television stations and networks, and much of the image processing, titleing and special effects are accomplished with digital circuitry. Digital television equipment will continue to replace elements of the broadcast chain, including parts of the TV receiver. Thus, establishment of a D-HDTV broadcast system is part of a natural progression from analog to digital systems.

Development of another analog standard for high-definition television may be short-sighted and short-lived, eventually to be replaced by a superior digital medium. The establishment of analog HDTV systems, especially those requiring complex and expensive augmentation channels, may leave broadcasters with no room to implement a truly superior approach.

Establishment of an ATV system within the 6 MHz NTSC-compatible domain provides an excellent interim standard, and provides time to develop a more optimal digital (D-HDTV) system as the next-generation standard.

5) Proposed enhancements to the present 6 MHz NTSC system appear to provide features and quality which rival more bandwidth-intensive HDTV approaches. A properly-designed NTSC enhancement (EDTV) system should satisfy a substantial portion of the television viewing audience, stimulate purchase of EDTV software products and supporting consumer equipment, and provide valuable time to optimize digital HDTV (D-HDTV) as the next-generation video standard.

The Advisory Committee suggests that the ultimate quality for HDTV is

> "an electronic image with a picture quality equivalent to 35mm film."[14]

The Committee goes on the state that

> "...efforts should be focused on establishing, at least ultimately, an HDTV standard for terrestrial broadcasting", and "It seems likely that viewers will eventually demand this level of reception quality and that non-broadcast media will offer it".[15]

The Advisory Committee recognize that there are a number of proposed systems which provide substantial improvements to the present NTSC system, referred to as "Enhanced Definition Television (EDTV)". Noting that the ultimate test of the demand for HDTV will be determined in the marketplace, the Committee adds

> "...one cannot foreclose the possibility that, as EDTV evolves toward HDTV, it may offer such significantly improved picture and audio quality that it will be accepted by the public as a competitive alternative to HDTV."

This, indeed, is the point of the several companies that are proposing enhancements to the NTSC system. Appendix A lists the known proponents of enhanced NTSC, along with the features or performance claimed for their system.

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14 Interim Report of the FCC Advisory Committee On Advance Television Service, R. E. Wiley, Chmn., June 16, 1988, pg. 5.

15 Ibid., pg. 6.

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A study[16] comparing the public's perception of various video systems shows that substantial visual improvements can be made to NTSC television. In terms of "just noticeable differences" (JNDs), the number of picture defects noticed in comparison with a "perfect" image dropped from 110 JNDs for "NTSC Today" to 50 JNDs for "Full NTSC". This shows an improvement of more than two-to-one in picture defects if all of the picture resolution in NTSC was available. By comparison, the European MAC systems JNDs ranging from 40 down to 20, but require luminance bandwidths from 5.5 MHz to 11.5 MHz, respectively, compared to NTSC's 4 MHz luminance bandwidth. Various EDTV systems, discussed elsewhere herein, promise further improvements in perceived picture quality while maintaining NTSC receiver compatibility and the 6 MHz channel structure.

An EDTV system, once chosen, can be quickly implemented and can attain penetration into the market more quickly than an augmented HDTV system since EDTV requires no spectrum reallocation and is compatible with existing domestic NTSC receivers. The cost to implement EDTV transmission is lower in both production and transmission stages, furthering its adoption by program producers and broadcasters.

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16 Curtis R. Carlson and James R. Bergen, "Perception Considerations for High-Definition Television Systems", SMPTE Journal, December 1984, pp. 1121-1126.

6) Video display devices, i.e., TV receivers, can be equipped at minimal cost with standard input/output ports to permit high-quality interconnection with RF tuners, VCRs, cable tuner/decoders. Such an interface will help avoid obsolescence of all parts of the consumer video system, especially the expensive large-screen displays. The study and consideration of this interface standard should be considered part of the overall ATS proceeding.

The development OF ATV services and programming could be helpful by the adoption of an equipment interconnection standard. Such a standard, such as RGB or Y/C (luminance/chrominance channel) interconnection, can be established independent of the transmission or storage format.

A consumer video display system could be provided with a baseband input port that will accept video signals from a broadcast tuner, cable, DBS, VCR, video disc, etc., without excessive cost or retarding the development of ATV. This interoperability would be valuable to consumers, who purchase new video equipment one step at a time. It is unreasonable to introduce a ATV receiver that cannot use the consumer's other equipment to maximum advantage (such as the "Super-VHS" VCR format).

The Advisory Committee supports this position, noting:

> "...the Committee believes that expeditious consideration should be given to the achievement of effective and inexpensive ATV interfaces between broadcast and non-broadcast media."[17]

Such interconnection standards already exist. Some new products have Y/C input and output ports, overcoming problems the "composite" NTSC system, but still compatible with NTSC. The Electronic Industries Association is working toward a universal standard referred to as "Multiport"[18], and the European Economic Community has a "SCART" connector similar in function to the EIA Multiport to handle conventional and HDTV signals.

As part of this Proceeding, the Commission should require that all future HDTV devices (receivers) sold in the United States should have an input port that would allow the device to display programming available from any media.

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17 Ibid, pg. 9.

18 EIA "IS-15 Multiport Standard", minutes of a meeting by the Television Receiver Committee (R-4), Audio/Video Baseband Interface Working Group, February 17, 1988.

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CONCLUSION

An Advanced Television System for the United States would be best served at present by a standard that enhances the present NTSC system. Prototype systems have been developed which show considerable improvements in picture quality, widened aspect ratio or other benefits. Adoption of such an enhancement system to NTSC represents the best combination of quality improvement and cost for consumers, program producers, and broadcasters alike.

A compatible enhancement system (EDTV) would serve as a welcome improvement to the television industry. Looking toward the future, it is highly likely that digital high-definition television will develop, higher in quality than any of the proposed systems now under consideration and that a broadcast transmission standard for digital high definition TV should be actively supported. EDTV would serve as a highly satisfactory interim broadcast standard until the advent of a truly optimum system.

Charles G. Perry III

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APPENDIX A

The following table sets forth a brief description of known single-channel, 6 MHz, NTSC receiver-compatible systems providing enhanced-definition television (EDTV). These systems have the capability of providing wider aspect ratio, increased resolution, or reduced picture artifacts, or a combination of these and other features. This table is not intended to be a comprehensive list of all proposed systems, but an example of EDTV development.

6 MHz, NTSC-Compatible EDTV Systems

Broadcast TV Assoc. of Japan - "EDTV-I"

Aspect Ratio:	4:3
Scanning Lines:	525
Scanning Technique:	progressive scanning and conversion to interlace scanning for transmission
Field Frequency:	60 (59.94/s)
Audio System:	FM (standard NTSC)
Stage of Development:	experimental transmissions with prototypes

Del-Rey Group System - "HD-NTSC"

Aspect Ratio:	14:9
Scanning Lines:	828
Scanning Technique:	2:1 interlace, pseudo-progressive scanning
Field Frequency:	60 (59.94/s)
Audio System:	digital sound
Stage of Development:	successful computer simulation

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APPENDIX A (Continued)

6 MHz, NTSC-Compatible EDTV Systems

Faroudja Labs System - "SuperNTSC"

Aspect Ratio:	4:3
Scanning Lines:	1050 (transcoding to 525)
Scanning Technique:	2:1 interlace
Field Frequency:	60 (59.94/s)
Audio System:	digital sound
Stage of Development:	successful public demonstration of prototype systems

Japan Broadcasting Corp. - "MUSE-6"

Aspect Ratio:	16:9
Scanning Lines:	525
Scanning Technique:	2:1 interlace, pseudo-progressive scanning
Field Frequency:	60 (59.94/s)
Audio System:	NA
Stage of Development:	prototype testing in real time

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APPENDIX A (Continued)

6 MHz, NTSC-Compatible EDTV Systems

Production Service Inc. - "Genesys"

Aspect Ratio:	not specified
Scanning Lines:	1125
Scanning Technique:	not specified (proposes a conventional NTSC signal and 1,125/60 within same 6 MHz channel)
Field Frequency:	60 (59.94/s)
Audio System:	digital sound
Stage of Development:	public demonstration of portion of system

Matsushita System

Aspect Ratio:	4:3 or 16:9, depending on whether on not luminance bandwidth is improved
Scanning Lines:	525
Scanning Technique:	2:1 interlace
Field Frequency:	60 (59.94/s)
Audio System:	FM (conventional NTSC system)
Stage of Development:	computer simulations of moving images

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APPENDIX A (Continued)

6 MHz, NTSC-Compatible EDTV Systems

RCA/NBC/Sarnoff Labs System - "ACTV-E"

Aspect Ratio:	5:3
Scanning Lines:	525 or 1050, depending on whether progressive scanning or interlace mode
Scanning Technique:	2:1 interlace for 1050 lines 1:1 progressive for 525 lines
Field Frequency:	60 (59.94/s)
Audio System:	digital sound
Stage of Development:	successful computer simulation; prototype hardware under development